panel measure a resultant 'distortion' in the characteristics of the reference field and send the information about the event to the processor **106** for mathematical processing.

[0023] An infrared touch screen panel may employ one of two different methodologies. One method uses thermal induced changes of the surface resistance. Another method is an array of vertical and horizontal IR sensors that detected interruption of a modulated light beam near the surface of the screen.

[0024] In a strain gauge configuration the screen is spring mounted on the four corners and strain gauges are used to determine deflection when the screen is touched. This technology may also measure movement of the screen **102** along the Z-axis.

[0025] In touch screen technology based on optical imaging, two or more image sensors may be placed around the edges (mostly the comers) of the screen. Infrared backlights may be placed in a camera's field of view on the other sides of the screen. A touch shows up as a shadow and each pair of cameras can then be triangulated to locate the touch.

[0026] Dispersive signal technology may use sensors to detect mechanical energy in the glass that occurs due to a touch. Complex algorithms then interpret this information and provide the actual location of the touch.

[0027] Touch screens based on acoustic pulse recognition may use more than two piezoelectric transducers located at some positions of the screen to turn the mechanical energy of a touch (vibration) into an electronic signal. This signal may then be converted into an audio file, and then compared to preexisting audio profile for every position on the screen.

[0028] Touch screens based on frustrated total internal reflection use the principle of total internal reflection to fill a refractive medium with light. When a finger or other soft object is pressed against the surface, the internal reflection light path is interrupted, making the light reflect outside of the medium and thus visible to a camera behind the medium.

[0029] Referring again to FIG. **1**A, each of the tactile pixels **104** includes an actuatable portion **105** coupled to an actuator **107** and a sensor **109**. The actuator **107** and sensor **109** are coupled to the processor **106**. The actuator **107** is configured to actuate in response to instructions from the processor **106** and the sensor **109** is configured to generate signals as inputs to one or more programs executed by the processor **106** when pressure is applied to the actuatable portion **105**. The actuator **107** may be any suitable electromechanical actuator. Examples of suitable actuators include piezoelectric actuators, MEMS actuators and magnetic coil actuators. The sensor **109** may be any suitable sensor, e.g., capacitive gauge sensor, piezoelectric sensor, resistive sensor, strain gauge and the like. In some cases, such as the particular case of piezoelectric devices, the same device may be used as both the actuator **107** and the sensor **109**.

[0030] The actuatable portion **105** is actuatable by the actuator **107** between first and second positions. A tactile feel of the actuatable portion **105** is different in the first and second positions. For example, as shown in the inset to FIG. **1**A, the actuatable portion **105** may be flush with or recessed below a surface of the case **101** in the first position and raised up above the surface in the second position. By way of example, the actuatable portion **105** may change from flush to protruding or vice versa or from flush to recessed or vice versa. Preferably, the actuatable portion is sufficiently wide and protrudes by a sufficient amount that it can be sensed by a users fingers. It may also be desirable for adjacent tactile pixels to be spaced sufficiently far apart that they may be distinguished. By way of example a protrusion of about 0.5 millimeters and an inter-dot spacing of about 2.5 millimeters is sufficient for sensing and distinguishing the raised dots that make up Braille cells.

[0031] There are a number of different possible configurations for the digital tactile pixels **104**. By way of example, and without loss of generality, the one or more digital tactile pixels may be located along perimeter of touch screen **102** on the same face of the device as the touch screen **102** as shown in FIG. **1**B. In this example, a user may hold the device **100** in the right hand and work the touch screen **102** with the index finger of the left hand. The tactile pixels **104** may be sensed by the fingers of the left hand. In an alternative embodiment, shown in FIG. **1**C, the tactile pixels **104** may be located along a side edge **122** of the device **100**. In another alternative embodiment, the one or more digital tactile pixels **104** may be located on a beveled edge **124** of the handheld device as shown in FIG. ID.

[0032] Furthermore, it is noted that in certain embodiments of the invention the device **100** may include two touch screens located on opposite faces of the case **101** and tactile pixels **104** located on one or more major surfaces as well as a side edge and one or more bevels. For example, as shown in FIG. **1**E, the hand-held device **100** may have a first touch screen **102**A disposed on a first major surface **125**A and a second touch screen **102**B disposed on a second major surface **125**B. Tactile pixels **104** may be disposed on the first major surface **125**A proximate an edge of the first touch screen **102**A or on the second major surface **125**B proximate an edge of the second touch screen **102**B. In addition, tactile pixels **104** may be disposed on a side edge **122** between the first and second major surfaces. Furthermore tactile pixels **104** may be disposed on a first beveled edge **124**A between the first major surface **125**A and the side edge **122** and/or on a second beveled edge **124**B between the side edge **122** and the second major surface **125**B.

[0033] The hand-held device **100** may further include a memory **108** (e.g., RAM, DRAM, ROM, and the like). The memory **108** may store program instructions **110** for execution on the processor **106**. The program instructions **110** may be configured to respond to inputs from one or more input sources on the device (e.g., the touch screen **102** or tactile pixels **104**) or remote input sources that are coupled to the device. The program instructions **110** may include touch-screen driver instructions **112** configured to respond to inputs from and generate images displayed on the touch screen **102**. The instructions **110** may further include another tactile pixel driver instructions **114**. These later instructions may be configured to selectively actuate one or more of the tactile pixels **104** and/or receive input from one or more of the tactile pixels **104** when execution of the program instructions reaches a predetermined state. The tactile pixels **104** are located in proximity to the touch screen **102** in such a way that the tactile feel of the device may dynamically change in response to program commands or the state of what is occurring on the touch screen **102**.

[0034] The hand-held device **100** may also include well-known support functions, such as input/output (I/O) elements **111**, power supplies (P/S) **113**, a clock (CLK) **115** and cache **117**. The device **100** may optionally include a mass storage device **119** such as a disk drive, CD-ROM drive, flash drive, or the like to store programs and/or data. The touch screen **102**, tactile pixels **104**, processor **106**, memory **108** and other